Award for Excellence in Supply Chain Operations

COLT—Reduce Customer Wait Time by 65% at No Extra Cost

Headquarters Air Force Materiel Command
CY02 Nomination

Table of Contents

Section 1: General Information and Project Complexity

1. Provide the name of the submitting organization.

    HQ AFMC/LGS/XPS

2. Identify the responding organizational unit (site, function, etc.).

    Depot Supply functions at the following sites;

    Oklahoma City Air Logistics Center (OC-ALC), Oklahoma;
    Ogden Air Logistics Center (OO-ALC), Utah;
    Warner Robins Air Logistics Center (WR-ALC), Georgia

3. Provide a brief mission description of the overall business objectives, product lines, and mission of the organization.

Business Objectives

The business objective for this submission is rather simple—optimize support to the warfighter.

Product Lines

For the purpose of this narrative, the product lines of AFMC are:

1) Repair of commodities, e.g. avionics, landing gear, etc.
2) Repair/overhaul of engines, e.g. F100, F108, TF39, etc.
3) Repair/overhaul of aircraft, e.g. B-2, F-117, KC-135, etc.

Note that consistent with the ensuing mission statement, AFMC develops, procures and sustains warfighting capability. However, this submission focuses solely on repair and overhaul functions of the AF Air Logistics Centers (ALCs).

Mission of the Organization

As stated by the HQ Air Force Materiel (AFMC) commander in the following AFMC https://warfighter.wpafb.af.mil/Entry.asp?Filter=W) :

> *"The mission of the Air Force is to fly and fight. In order to fly and fight we need to have great systems to do that. AFMC is about providing the capability to support our national security objectives and allow our people to fly and fight effectively."*
>
> *General Lester Lyles,*
> *AFMC Commander*

The headquarters function supports this goal through the development and implementation of policy, the advocacy for and allocation of funding, and by balancing a strategic focus with current operational objectives and financial constraints. The ALCs support this objective through the procurement or performance of repair/overhaul actions that yield weapon system capability to support present and future warfighter needs.

4. Indicate the award category of the submission (operations, academic, technology).

   Operations

5. Provide a brief description of the supply chain and the processes the submission spans (Plan, Source, Make, Deliver, Return, etc). ***– 15 pts***

Description of the Supply Chain

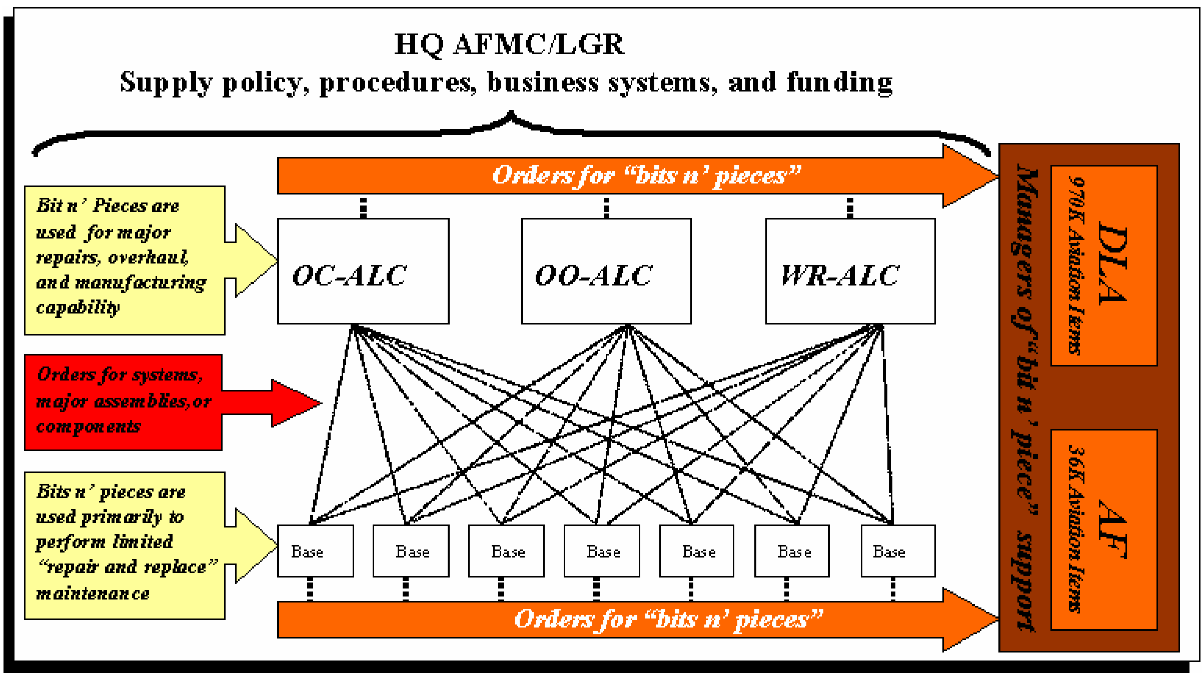


Figure 1. A Simple View of the Supply Chain

As illustrated in Figure 1, HQ AFMC/LGR (formerly LGS) provides supply policy, procedures, business systems, and funding to AF wholesale supply activities—the ALCs. In particular, HQ AFMC/LGR provides oversight and funding to the ALC supply activities that directly support three major product lines: 1) repair of commodities (end items for other systems, e.g. landing gear, radars), 2) repair/overhaul of engines, and 3) Programmed Depot Maintenance (PDM), i.e. periodic inspection and overhaul of aircraft and missiles. The primary function of the ALC supply activity is to ensure spare parts—bits n' pieces—are available on-demand to support maintenance actions in any of the three product lines. As a means of assuring these bits n' pieces are available when needed, the ALC supply activities compute stock levels for Defense Logistics Agency (DLA)-managed consumable parts. These stock levels are computed by the Wholesale and Retail Receiving/Shipping (WARRS) System (D035K) and then filled predominantly through requisitions to DLA sources of supply. The General Support Division (GSD) funds these requisitions to DLA, and is reimbursed when ALC maintenance activities (Depot Maintenance Activity Group—DMAG) procure the items. As depicted in Figure 2, of the more than 970K aviation investment items managed by DLA, the AF ALCs order more than 170K different bits n' pieces from

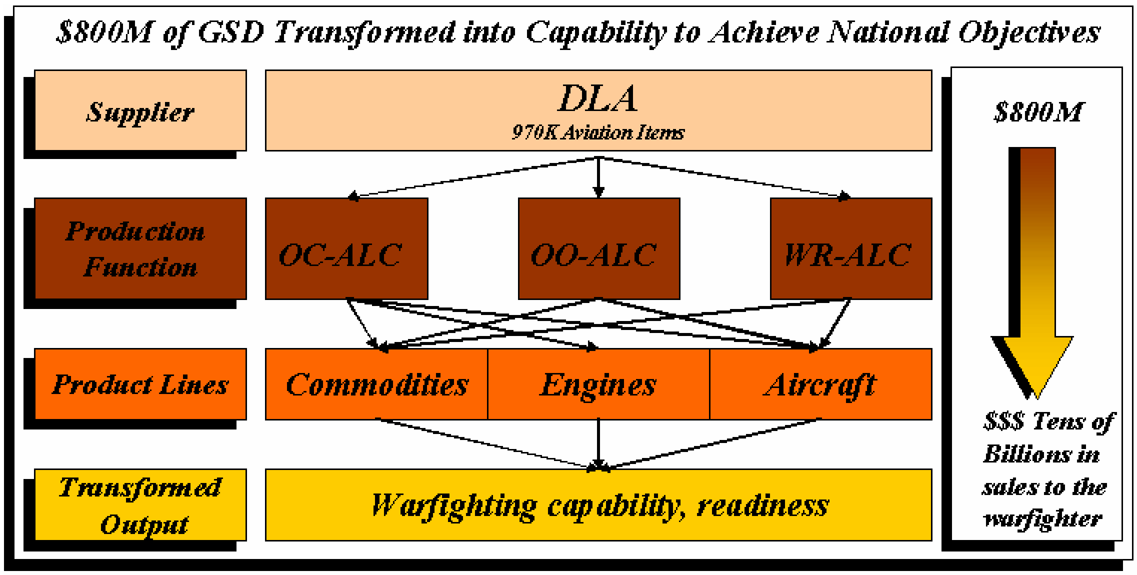


Figure 2. Transforming DLA bits n' pieces into warfighting capability

GSD each year—valued at over $800M. In turn, these 170K active line items valued at over $800M in annual GSD sales support the sale of over $8.3B in engines/commodities and tens of billions of dollars in upgraded/overhauled aircraft—to the warfighter. AFMC's bottom-line goal is to maximize supply support to depot maintenance at all three ALCs—subject to available funding. Traditionally, the merit of the funding allocation process was measured by stockage effectiveness (SE)—the percent of time an historically stocked asset is available at the time it is requested. More directly, the merit of the funding allocation process was also measured by the number/percent of incidents the ALC maintenance functions had to wait for bits n' piece—referred to as awaiting parts (AWP) incidents. To mitigate the impact of an AWP incident, the goal is to minimize the amount of time the mechanic has to wait. In summary, the parts the ALCs repair are either used to keep aircraft and engine production on schedule or are sent out to operational units in the field to keep aircraft and other weapon systems mission capable.

This Submission Spans the Following Processes...

This section discusses the different segments of the Supply-Chain Operations Reference (SCOR) model that apply to this submission. As an overview, this project primarily involves the *planning* of DLA bits n' pieces needed to repair spare parts and support PDM schedules. Next, how the bits n' pieces are *sourced* from DLA, and then used to *make* serviceable end items to meet base-level needs and Programmed Depot Maintenance (PDM) schedules. The intent of this project was to leverage wholesale and retail supply information within available funding to reduce the delay times for consumable spares needed to perform repairs on end items for DOD weapon systems.

Plan

The most fundamental aspect of this submission lies in the planning activities of the ALCs. Annually, the ALCs perform a workload review of their anticipated production requirements and their forecasted capacity to meet those requirements. At the lowest level, the workload review assesses the ALC's ability to meet the needs of the AF bases and the requirements of the PDM/overhaul processes. Of particular importance to this discussion, the plan for DLA units/dollars required to satisfy the anticipated repair/overhaul requirements is reflected through the following two processes:

1) Stock levels for DLA bit n' pieces that are unique to each ALC
2) The budgeting process that funds those levels

Historically, stock levels fluctuated in concert with actual consumption patterns, and funding was based on the historical sales of DLA bits n' pieces at an ALC. As Figure 3 depicts, the ALC production plans are designed to meet warfighting capability targets. However, the ALCs did not assess the ability of stock levels or funding required to achieve their production objectives.

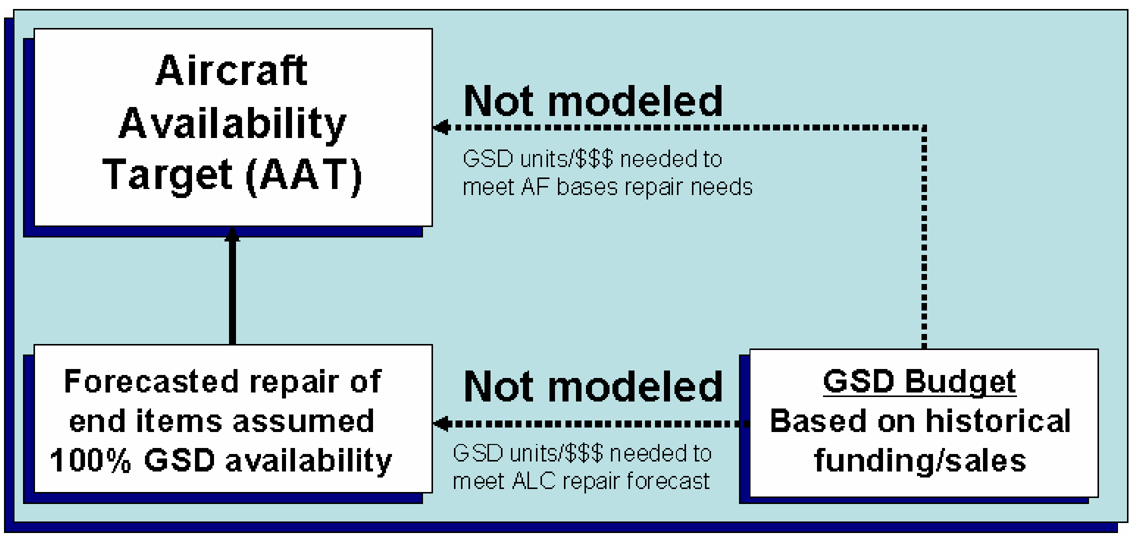


Figure 3. How did we plan for GSD requirements?

Source

DLA is the source for than 83% of the consumable line items required to perform the vast majority of the repair, overhaul, and PDM processes at an ALC. In particular, this project looked at the following processes related to sourcing items from DLA:

1) What was the historical availability for a given bit n' piece
2) To what degree were DLA stockage policies in concert with AF ordering policies
3) How could AF ordering policies be adjusted to optimize support of DLA stockage policies

4) What was the impact of AF stock leveling policy on performance of DLA item availability

Just as significant as the support afforded by DLA, this project also looked at the sourcing process for funding. In particular, what was the historical budgeting process for determining the requirement for GSD obligation authority? What was the flexibility to increase GSD obligation authority to satisfy short-term requirements or compensate for periods of abnormal variability in consumption?

Make

After assessing the planning and sourcing processes, this project then reviewed the production processes that consumed the DLA bit n' pieces. As part of the "make" process, this project reviewed the *constraints* within the depot repair process. The AF categories these constraints into four areas:

- Funding
- Shop capacity/capability
- Carcasses (the unserviceable end item to be repaired)
- Consumable piece parts

This effort specifically focuses on reducing the amount of time that mechanics in depot maintenance functions spend waiting for *consumable piece parts*, whether for component repair or for PDM. The level of support that ALC supply functions deliver to depot maintenance directly impacts the number of reparable items in an AWP status. In turn, items in AWP status reduce the availability of end items to the flying units in the field as well as to the PDM activities, which are trying to keep aircraft overhauls on schedule. In the end, it directly affects the availability and readiness of AF and DoD weapon systems to perform their peacetime and wartime missions.

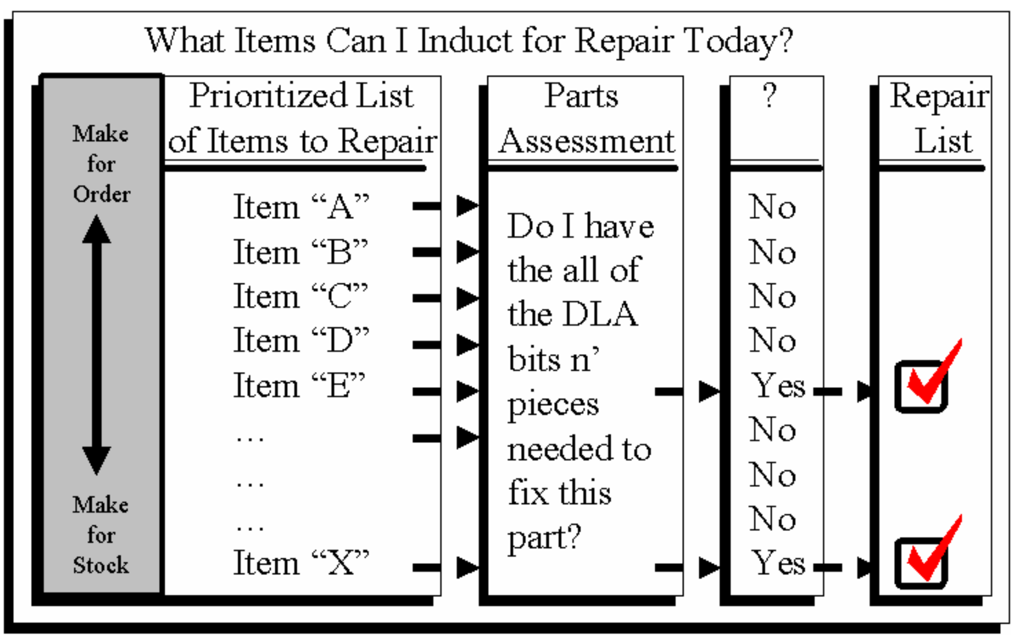


Figure 4. What is the impact of not having bits n' pieces?

As Figure 4 illustrates, when bits n' pieces are not available, the warfighter will have to wait for "make to order" items—and the ALC will be driven to induct items that have a less pressing need.

Deliver

Another key function of this link in the supply chain is to distribute the GSD funding that comes to the ALCs. Each ALC performs different types of repairs on different types of weapon systems/components: they consume a different amount of stock each year and have a different amount of inventory on the shelves. Historically, this variability in product mixes—compounded by the idiosyncrasies of each end item's life cycle and consumption profile—has made the overall stock setting and funding allocation process very challenging. Some ALCs have performed better than others, due to varying levels of expertise, local automation, different funding levels, etc. The project described in this narrative defines a new standard and defendable methodology for determining stock levels (*planning* and *sourcing*) and distributing funding—*delivering*—that provides an optimal level of bit n' piece support across the three ALCs.

Return

This project viewed the "return" process from a very unique perspective. The forecasts and level setting processes for bit n' piece parts are based on the assumption that history repeats itself—to varying degrees. As such, forecasts are made, and levels are set in anticipation of unserviceable assets being returned for repair—and as such, bits n' pieces are needed to restore those assets to serviceable condition. In optimizing the level setting process, the new algorithms considered the number of bits 'n pieces needed per expected repair action, and rounded levels to the number of "whole" repair actions. Again, this is a very unique perspective of the return process—and how it influenced the planning, sourcing, and making processes.

6. Provide the names of the supply chain partner organizations (external) involved in the project. Indicate the number of people involved from each partner organization and the functional category of each.

External Supply Chain Partners	***# of People***	***Functional Category***
OC-ALC/MAM	1	• Field Operations • Program Development • Systems
OO-ALC/MAM	3	• Field Operations • Systems
WR-ALC/MAM	4	• Field Operations • Program Development • Systems
HQ DLA/J-3	3	• Staff Analysis
DDC/J-3	5	• Field Operations

7. Provide the names of the functional organizations (internal) involved in the project. Indicate the number of people involved from each functional organization and the functional category of each.

Internal Functional Organizations	***# of People***	***Functional Category***
HQ AFMC/LGR	6	• Staff Analysis • Project Management • Systems
HQ AFMC/LGP	1	• Staff Analysis • Systems
HQ AFMC/XPS	3	• Program Development • Systems

8. Provide a POC for each supply chain partner (name, mailing address, commercial telephone number, DSN, and e-mail address).

HQ AFMC/LGR (Mr. Don Kringen)
4375 Chidlaw Road – Suite 6, WPAFB, OH 45433
(937) 257-4465, DSN 787-4465
Donald.kringen@wpafb.af.mil

HQ AFMC/LGP (Mr. Matt Phillips)
4375 Chidlaw Road, WPAFB, OH 45433
(937) 904-0061, DSN 674-0061
Matthew.phillips@wpafb.af.mil

HQ AFMC/XPS (Mr. Rich Moore & Capt Jason Vincent)
4375 Chidlaw Road – Rm B204, WPAFB, OH 45433
(937) 257-4044, DSN 787-4044
Richard.moore@wpafb.af.mil, Jason.Vinson@wpafb.af.mil

DLA (Mr. Al Bertleff)
4375 Chidlaw Road – Suite 6, WPAFB, OH 45433
(937) 257-8576, DSN 787-8576
Alfred.bertleff@wpafb.af.mil

Section 2: Implementation

1. Explain why the supply chain initiative was undertaken and how it was selected **– 10 pts**

Why was this Initiative Undertaken?

In 1999 and 2000 KPMG Consulting (now Bearing Point) performed a study, called the Constraints Analysis Program (CAP). That analysis identified consumable piece part support to depot maintenance as one of the six constraints limiting the ALC's ability to:

1) Complete PDM within cost and schedule
2) Efficiently/effectively produce end items for warfighter "make to order" requests and prepositioned levels

The CAP analysis postulated that increasing the availability of consumable parts would likely lead to increased repair facility productivity. Furthermore, the CAP analysis stated that not all items should be treated the same way by the supply system and, as a result, inventory stratification was briefed to and approved by the AFMC/LG. At that time—and still today—D035K was/is very limited in its flexibility and there has been a great deal of effort in this area at each of the ALCs. Subsequently, the Stockage Policy Integrated Product Team (IPT) was formed to develop a new, standard, stockage strategy for AMFC. Given the relative inexpensive nature of bit n' pieces vs. the serviceable inventory they support, this was a logical "first step" in resolving the constraints identified in the CAP.

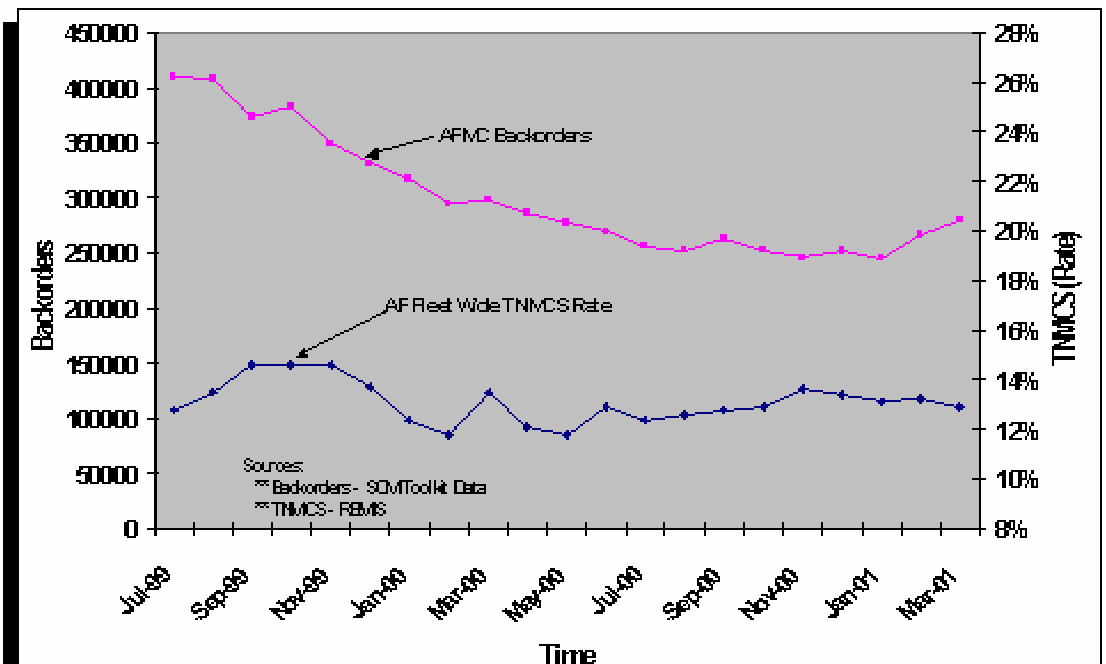


Figure5. TNMCS Was Not Decreasing With Rate of Backorder Decline

As the figure above depicts, in addition to the CAP analysis, the AF was witnessing a drastic decline in backorders—with relatively no gain to show in its Total Not Mission Capable Supply (TNMCS) metrics. TNMCS is a measure of the amount of time that weapon system availability is degraded due to the on-availability of supply parts. In light of this trend, it raised the general question, is AFMC applying its stock fund to the best items in terms of improving weapon system availability? Furthermore, as noted earlier, $800M in DLA bit n' pieces support the production of tens of billions of dollars in sales to the warfighter—literally pennies on the dollar. As such, CAP and irreconcilable trends provided significant insight and impetus which facilitated the undertaking of this initiative. Last, the only options to improve support to the warfighter were to:

1) Determine if there's a better methodology of level setting for DLA items
2) Spend hundreds of millions or several billion dollars to augment reparable item inventories to compensate for variability in bit n' piece support
3) Spend billions of dollars for additional weapon systems/aircraft to compensate for the variability in end item availability which is driven by variability in bit n' piece support

As such, financially, this initiative was the least prohibitive and offered the most to gain with the least possible investment.

<u>How was it Selected?</u>

In March 2000, an IPT was chartered by AFMC's Director of Logistics to look at methods to improve support on these consumable parts. The IPT, lead by then Lt Col, now Colonel Mark Douglas, was comprised of members from the supply divisions at each of the ALCs, the HQ AFMC Supply Division (formerly LGS—now LGR), the HQ AFMC Studies and Analysis Office (XPS), and DLA.

Why the Need for a "Customer Oriented Leveling Technique" (COLT)"?

Initially, the IPT conducted an in-depth analysis of the existing stockage polices, metrics, and initiatives—and tried to understand where these efforts had fallen short. For example, historically, the depot retail supply system (D035K) used a traditional Economic Order Quantity (EOQ) model to set stock levels (similar to the method used by the base level supply systems). However, the IPT determined that in many cases, D035K ordered stock so infrequently that the policy actually "drove" poor support from DLA. The AF algorithm tended to order annual demand quantities—large amounts of stock. Operating this way, EOQ orders at the beginning of a fiscal year will tend to be for annual quantities—thus reducing flexibility of the stock fund when the obligation authority ceiling has been met. Conversely, DLA algorithms more optimally support smaller demand quantities. These concepts are illustrated in Figure 6 on the following page. Note that the EOQ model is attempting to minimize the sum of annual variable holding and ordering costs—in the absence of knowing what the Unit Cost Ratio (UCR) or annual obligation authority target. Conversely, the finalized COLT model seeks to minimize expected backorders through minimizing CWT—as a function of the available obligation authority, and in concert with the established UCR.

In response to the inconsistencies in EOQ , AFMC adopted "1-for-1" ordering in 1998 to improve DLA's visibility of the true customer demand stream. However, the implementation of the "1-for-1" policy varied drastically across the ALCs – there was no consistent policy across the command. Additionally, all previous initiatives focused on the well known issue effectiveness (IE) (percent of time any item is immediately available for a customer demand) and stockage effectiveness (SE) metrics, both of which fail to capture the length of time that backordered requisitions stay on order. For example, if a mechanic ordered 10 parts that were needed to complete a job, and 8 were immediately issued from depot supply, the IE would be 80%. But if the 2 that weren't immediately available then took 2 months to be sourced and delivered, the job was stalled all that time in an AWP condition. As an alternative, the IPT adopted customer wait time (CWT), which accounts for the time it takes for supply to issue a part, regardless of whether the item is immediately available or has to be ordered from DLA.

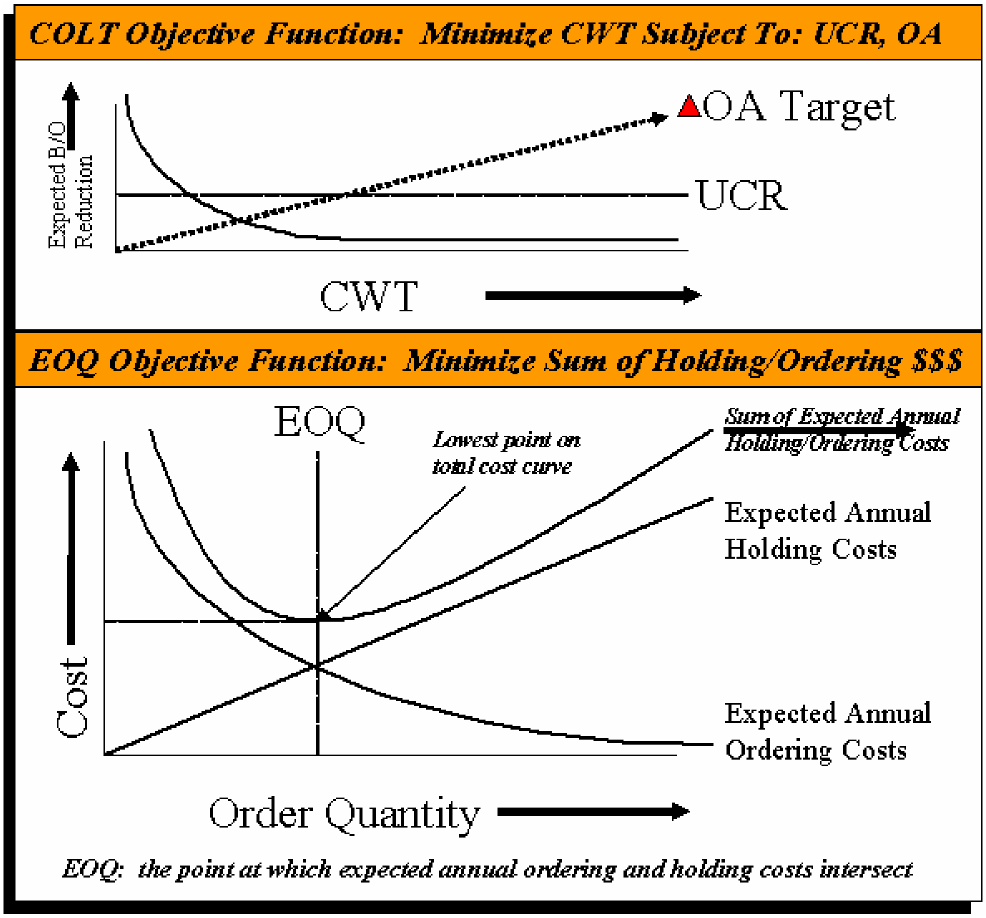


Figure 6. COLT vs. EOQ Objective Functions

Armed with an understanding of the consumable parts history, the team created and analyzed several alternative stockage policies, assessing each option in light of the expected cost, performance, and risk. Of particular concern was the ability to change the method for setting stock level without increasing the requirement for obligation authority. It generally takes up to two years to acquire additional dollars for GSD items—because of the time it takes to submit new requirements in the Program Objective Memorandum (POM) process. Following this initial analysis, XPS developed a new alternative—COLT. This new level setting technique took into account known wholesale (DLA) support data when setting the retail stock levels – *leveraging* this information to improve the return on investment from AFMC's existing inventory of consumable parts.

COLT Receives a Cautious Endorsement from ALC Leadership

Exhaustive analysis predicted that the policies contained within COLT had the potential to reduce CWT by up to 80% across AFMC without increasing the size of the inventory or requiring any increase in funding. The AFMC LG at the time fully endorsed the initiative and it was implemented with the cautious enthusiasm of the senior leaders at each of the three ALCs.

From implementation of COLT in August to October 2001 through 1 February 2003, average CWT for DLA-managed piece parts for all three AF ALCs has decreased by 65% since implementation and the trends indicate that further reductions can be expected.

2. Indicate the duration of the project. Note if the project was a pilot that is being rolled out. Note if the project is ongoing or still in development. **– 5 pts**

Duration of the Project

The IPT met for the first time in March 2000 to discuss alternatives and focus on the overall project objective. A prototype of the solution was completed in March 2001 and the first "full-up" version was deployed to the Ogden ALC in August 2001. All three ALCs were up and running with the new system by 1 November 2001. During the period of this award nomination, the IPT:

1) Continuously assessed model performance
2) Quantify the effects to operational stocks and stock fund performance
3) Met to revise the logic of the model
4) Ensured that operational and financial objectives were being met
5) Determined if projected improvements fell short, were realized, or exceeded

The COLT model has been distributed to each of the ALCs, and the IPT continues to meet periodically to discuss, analyze, and plan minor model and process improvements.

While the initial tasks of the IPT have been satisfied, the a parallel initiative has been started with Air Education and Training Command (AETC) and Air Combat Command (ACC) to test the applicability of these concepts at the base level retail supply activities. Preliminary results from these tests are expected toward the end of September 2003.

3. Describe, in detail, the process used to complete the initiative. **– 15 pts**

Process Used to Complete the Initiative

COLT is a government-owned Microsoft (MS) Access database that is installed and run on a personal computer (PC). The first phase of the development was to give COLT access to all of the data needed later in the processing. Links were established with the D035K accounts at each of the ALCs – this link provided information on the unit prices, demand rates, demand patterns, and order quantities of the parts as well as to the cataloging information for each item. This link to D035K is "live," meaning that the data is new each and every day that the model runs. Next, COLT was given wholesale data regarding the expected level of support from DLA by stock number. Once per quarter, DLA provides an automated file transfer from its supply systems that updates a set of data for COLT. This DLA data shows the expected percentage of the time that an item will be available, the historical wait times when they have run out of the item, and their current asset balances by location.

COLT uses all of the information from Phase 1 to set optimal stock levels during Phase 2. Again, "optimal" is defined here as minimizing the expected wait time for consumable parts for a given level of investment in inventory. COLT uses a marginal analysis technique, similar to that used in other Air Force logistics models, to allocate the available funding to the parts that will yield the largest return on investment, or "bang-per-buck." Stated another way, for every dollar that the model invests in consumable inventory, COLT finds the part where the next $1 will result in the largest reduction in average CWT across the population of parts being considered. This iterative process continues as long as the levels being set don't violate any of the user defined financial constraints – the budget. Phase 2 ends with a list of level changes, in MS Access, that COLT says will produce the lowest possible average CWT for the set level of investment in inventory.

For the first time ever, during phase 2, retail stock levels were set according to a set budget and taking into account expected levels of DLA support. By understanding which items DLA has readily available and which items have short delay times when they stock out, COLT is able to shift AFMC's limited inventory investment towards the parts that require larger buffer to guard against long delays in the event of a stock out.

As an added benefit of setting stock levels based on the budget, AFMC now had a tool that would aid in distributing the GSD funding each year. Historically, funding was passed out based on the percentage of past years' sales that came from each site. While this methodology is correct if the inventory investment is distributed optimally, this was not the case when COLT was first implemented. Instead the model showed that the previous distribution of funds did not provide the right allocation to insure the best total level of support from AFMC to its customers. By shifting the investment mix, each ALC realigned them selves to make AFMC more efficient as an *enterprise*. Perhaps the best thing about using COLT to pass out the GSD budget is that it removed emotion from the equation and resulted in a distribution that could be defended in terms of optimizing customer support.

In the final phase, the IPT decided to use an existing process to "feed" the level changes into COLT. Working with systems experts at each of the ALCs, AFMC/XPS configured COLT to export its proposed levels changes in the form of a flat text file of data that was easily fed into D035K through an existing mechanism.

4. Identify significant challenges encountered, the process for resolution, and the solutions. Identify any best practices employed or developed. **– 10 pts**

Challenges, Resolutions, Solutions

There were four significant challenges faced during the development and implementation of COLT. The first involved convincing senior leaders to make this transformational change with the risks to their operational environment. The next two challenges dealt with paradigm shifts in the supply community and the fourth involved a financial practice that was not accurately captured in the first version of the model. In all four cases, the process for resolution was to analyze the scenarios, understand the implications, and educate users on the results of the analysis.

Cultural Resistance

First, it was very difficult to educate and convince senior leaders at the ALCs on the projected benefits of using COLT versus their perceived risks. Admittedly, this new software would completely reshape their stock levels within a day—as many as 40,000 level changes per ALC. With such drastic changes, the ALCs had great concerns that the supply processes for which they were responsible would be severely degraded—overnight.

Senior leaders were rightfully apprehensive. After site visits and briefings to senior leaders at the ALCs, numerous actions by IPT members, and the support of HQ AFMC's Deputy Director for Supply Management, COLT was finally implemented at OO-ALC in August 2001. Then, after initial results met expectations, the other two ALCs came on line in the next two months.

Level Setting is a Function of Available Funding

The second challenge faced during the development of COLT was the shift to setting stock levels as a function of the available funding. In the past, levels were set independent of the annual budget and as a result stock replenishment was typically suppressed towards the end of the fiscal year – indicating that the majority of the funding had been expensed. With COLT, instead of running out of money towards the end of the year, the model will actually reduce some stock levels, earlier in the year, to stay within the budget – reducing the amount of money spent on stock replenishment. The analysis showed that CWT would be significantly reduced despite this lowering of stock levels on some items. This new practice also ensured that money needed to cover work stoppage backorders in the closing months was not spent on replenishment earlier in the year.

CWT—The Driving Metric

The third challenge was a shift in the primary supply performance metric to CWT, away from issue effectiveness IE and SE. This was a significant step forward in driving improved support to customers. IE and SE gave supply a great feel for the percentage of the time that they had the parts on the shelf that their customers were asking for, but did not account for the amount of time those same customers had to wait when the parts went to backorder. The specific goal of COLT was to minimize the total CWT, without regard for the number of immediate issues. The thinking behind this push is that the customer cannot complete a repair action until all needed consumable parts have been received. CWT gives a much better feel for customer support. The first key IPT action was to define how we would measure the merit of proposed stockage strategies. Issue and stockage effectiveness have been the standard, but we have introduced a new measure to this environment…customer wait time. CWT is the average amount of time that depot maintenance has to wait for a part from depot supply. The equation below shows what this means in a mathematical equation. Simply stated, CWT accounts for the percentage of time that supply has the requested part (IE) as well as a separate factor that accounts for how long maintenance has to wait for the item once supply stocks-out.

- CWT = [IE * 0] + [(1 – IE) * (Time on Backorder)]

CWT accounts for the percentage of the time that depot supply has the part on the shelf (IE) and the fact that there is essentially "zero" delay in these cases—and then the percentage of the time that depot supply has to backorder the part times how long, on average, it takes to satisfy the requisition. While IE is a partial metric, CWT tells the complete story. Finally, we measured the financial implications of each proposed stockage strategies—the UCR. The UCR is a fiscal constraint imposed upon the ALCs to prevent them from buying too much slow moving stock.

GSD—Cash Poor

Lastly, about halfway through the first year of implementation, the GSD, which pays for the consumable assets described in this paper, was in a very poor cash position. There were a number of independent actions that contributed to that position, one of which was a business rule contained within COLT. Specifically, the model originally governed the stock levels using the UCR alone – UCR is simply the ratio of sales versus obligations (with consideration for credit returns), but does not show when the "overall" authorized obligation total is reached. Throughout this particular year (which was somewhat of an anomaly due to OPERATION ENDURING FREEDOM), ALCs were surging and sales were increasing every month over the rate that were expected to come in – the demand rates for parts were going up. Each time COLT ran it saw that additional sales were coming in and that additional obligation authority would be available as a result. In essence, COLT was trying to get ahead of these increasing sales so that customer support wouldn't be negatively impacted. All of this was happening within the prescribed UCR that was set by the users of the model. In practice, however, it was discovered that additional obligation authority (OA) does not automatically increase as sales themselves increase. In fact, additional OA in the year of execution must be requested and approved, so the business rule of only tracking the UCR was faulty. This error led COLT to spend more money earlier in the year than it should have. However, in the end, additional obligation authority was approved to cover the increased depot activity in support of the war on terrorism. Subsequently, the new UCR was correctly achieved by the model at the end of the fiscal year. Additionally, a new constraint was added to the model to prevent this situation from recurring.

The development and implementation of COLT certainly did not go without issue, but in the end a very valuable tool has been adopted that is making great leaps toward reducing the wait times for consumable spare parts.

Best Practices—Employed or Developed

Optimizing Performance within Fiscal Constraints

Prior to the implementation of COLT, leveling algorithms took into account the price and average demand of an item over time. COLT looks at the same factors, but also looks at the variability of the demand pattern—and the mean and variability of the expected DLA pipeline time. In addition to using information about the DLA pipeline, COLT also looks at item individually as opposed to in groups—these differences set this new methodology apart from traditional stock leveling algorithms. As illustrated in Figure 7 on the following page, while keeping within fiscal constraints, COLT will minimize the total expected CWT for a given cost by using a marginal analytic approach to pass out available dollars. It does this by taking each dollar that it has to allocate and looking across all of the items in the population to determine the one item that gives us the largest bang for the buck in terms of CWT reduction. In short, there are three reasons why COLT performs better than traditional stock leveling strategies:

1) COLT considers items individually rather than in groups, but still acknowledges that one-size doesn't fit-all
2) Accounts for DLA expected performance
3) Targets CWT as opposed to other internal supply metrics (IE/SE)

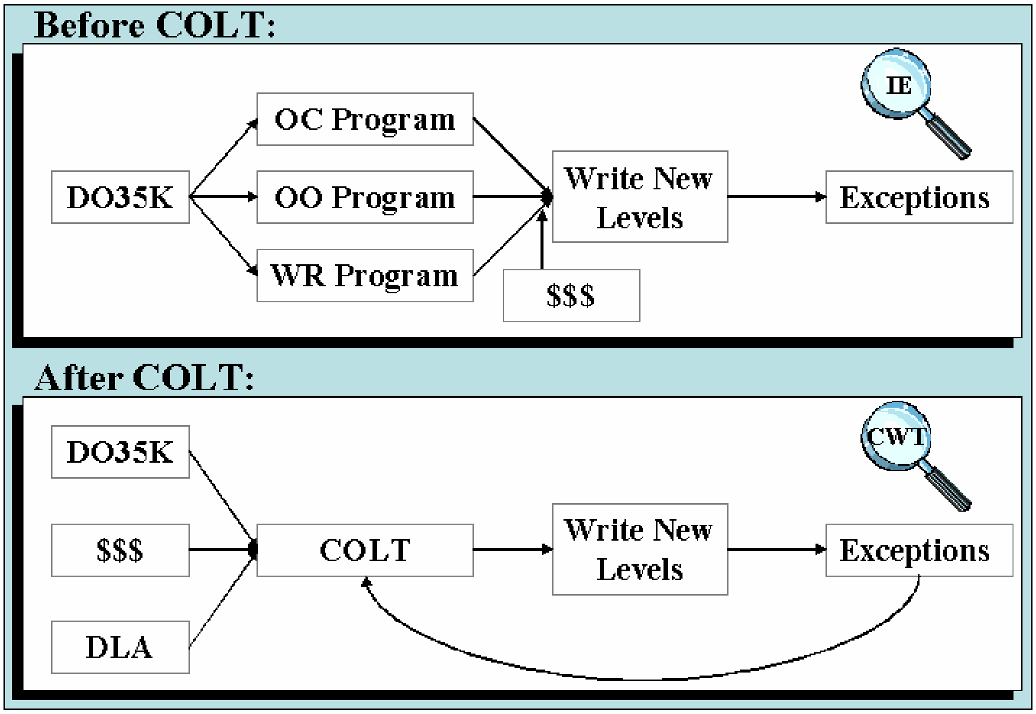


Figure 7. "Before" & "After" COLT

Process Improvements

In the process of developing COLT, there were four major outgrowths—each of which represented significant process improvements. First, COLT allowed financial planners and logistics alike to calculate the investment required to reach a CWT target. This information facilitated the development of budgets that were based on objective performance targets—rather than historical expenditure rates. Second, COLT allowed HQ AFMC to determine the optimum budget allocation amongst the ALCs—subject to achieving optimum system performance, vs. distributing funds based on historical consumption. Third, COLT represented a new methodology for developing, computing and distributing levels. Using common software, a common PC, and existing file transfer capabilities, the IPT was able to develop, institute, analyze, and refine an entirely new method of computing and updating stock levels—a process normally measured in months vs. years by existing software/system development standards. Last, the analysis capabilities that emanated from the development of COLT provided unprecedented insight for financial, program, and logistics managers. "What if" analyses for CWT or UCR now offer insight into item-level data to address DLA support issues or substantiate funding needs to the Air Staff.

5. Indicate the metrics used to measure progress and success. **– 5 pts**

Metrics Used to Measure Progress and Success

There were two key metrics that the team focused on throughout this effort – CWT and UCR. CWT measures operational performance, while UCR measures financial performance. CWT was defined as the amount of time from customer request until the time that the part was available for issue in the retail supply system.

UCR actually served as more of a constraint metric than a performance metric in that it served as the "throttle", limiting the amount of money that COLT could spend. Each time the model was run, the objective function was to minimize CWT while simultaneously ensuring that the user-defined UCR was met by the end of the fiscal year.

In addition, AWP rates for DLA-managed consumables were used, and were compared to AWP rates for AF-managed consumables—which are computed without using COLT logic. AWP is an important metric because it defines the percent of time a maintenance job is awaiting piece parts.

In tandem, these metrics ensured operational performance was optimized within stated cost parameters.

6. Document and quantify cost and performance benefits, including the projects return on investment and changes in the value of one or more of the SCOR Level 1 metrics (not all metrics must be captured or reported) **– 15 pts**

Cost and Performance Benefits

First and foremost, there was no inventory augmentation cost associated with the implementation of the new stockage policy. By definition, all inventory shifts were accomplished by operating within the set UCR. It is important to point out, however, that the course of action recommended in the extensive CAP study, referenced earlier, called for an estimated plus up of between $15M and $20M to improve support. This initiative was implemented without increasing the obligation rate.

Second, the return on investment for this effort is difficult to quantify, but for the purpose of this write-up, an estimate has been provided. All work performed on this initiative was accomplished by government-owned resources (military and civilian). Approximately 2000 man hours have been invested in the development and implementation of the tool. Although it is a sunk cost, these hours translate to an invested $75,000 - $100,000 in wages. Additional costs—including IPT meetings, education trips, and implementation trips—are estimated at a maximum of $40,000 for TDY expenses. Please note that these funds came out of existing office budgets – no additional funds were allowed for this effort. All software required for this project came at no cost to the government, making the total investment $115,000 to $140,000.

Being extremely conservative, the investment in inventory required, under old practices, to decrease CWT by 65%, down to 2.45 days, would have been at least $15M to $20M, as estimated by the CAP study. Said another way, the value of the performance

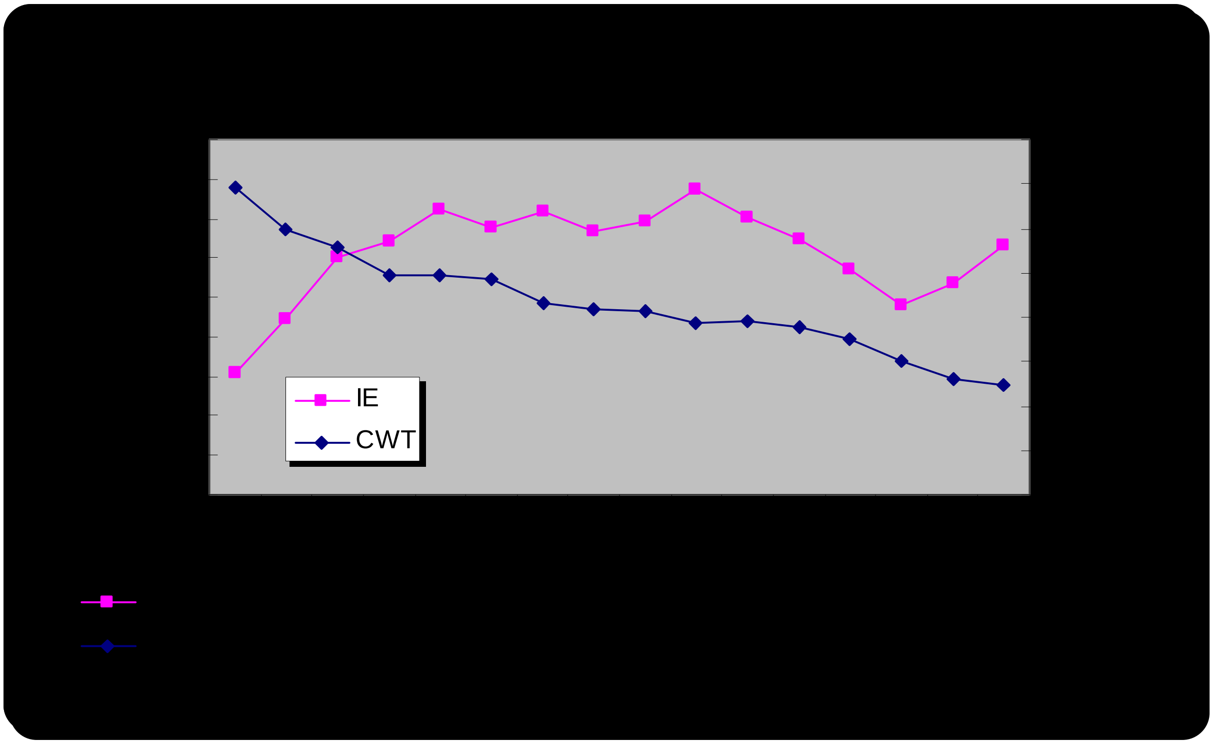
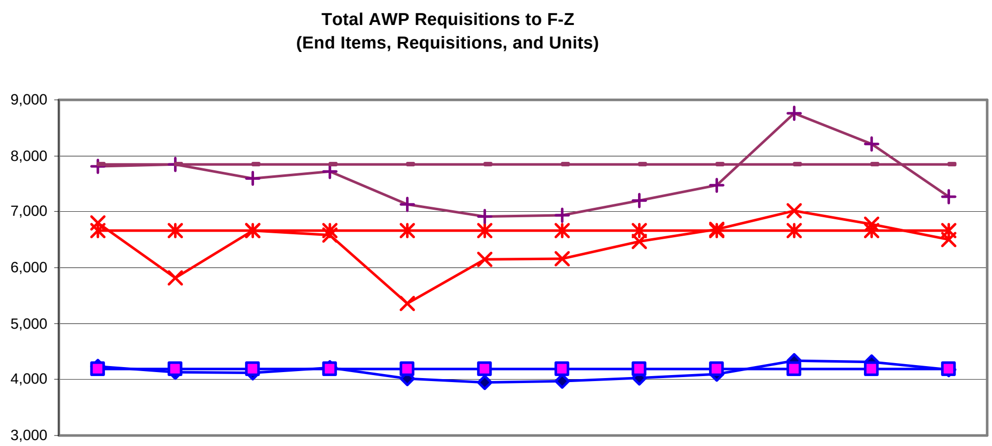


Figure 8. AFMC Issue Effectiveness and Customer Wait Time

improvement is at least $15M. Based on these estimates, the AF investment of $140K yielded a net return of $14.86M—***a return on investment of 107, or over 10,000%***, realized in just over one year after implementation! These numbers are estimates, but it is important to note that, if anything, they are *understating* the return on investment.

Next, the key performance metric falls under the area of Supply Chain Delivery Reliability, the Level 1 metric Delivery Performance. As reflected in Figure 8, COLT has reduced CWT across AFMC from 6.94 days on average to 2.45 days – a 65% improvement. These dramatic reductions displayed the total transformation of the stock level setting strategy. Some minor fluctuations in CWT performance have occurred, but appeared related to similar fluctuations in the overall funding allocations to AFMC by the AF. Current trends indicate that the average wait time may continue to drop. As seen in the chart above, the CWT reductions were delivered without reducing the issue effectiveness across the command – an indication that wait times are truly going down.

As an added benefit of reductions in CWT, there has been a significant drop in the number of AWP backorders in the system for DLA managed consumable items. As noted in Figure 9 on the ensuing page, AWP units declined 540 units from Jan 02 – Dec 02, a 6.9% decrease. Furthermore, note that were it not for the constraint of the UCR, units AWP would have likely remained below 7K units, as witnessed in Jun 02—a 12% from the Jan 02 starting position of 7,809 units. Considering that implementation of COLT was by far the single biggest change to the stock levels for DLA-managed items, the current level of AWPs demonstrate the positive effect of this initiative. This number directly translates to a reduction in average repair cycle times, reducing overall wait times for parts to the field and to PDM. Adding further weight to COLT's impact on this metric is the comparison to AF-managed consumables as a "control group". During the same period, and despite increased funding being applied, the trend for AF-managed AWPs remained relatively unchanged.



	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02
E/I w/F-Z B/O	4227	4133	4113	4212	4020	3949	3966	4024	4097	4339	4312	4180
E/I UCL	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955	4189.3955
Reqns to F-Z	6804	5819	6663	6581	5360	6151	6165	6469	6689	7012	6781	6505
Reqns UCL	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997	6660.0997
Units to F-Z	7809	7850	7597	7718	7127	6907	6937	7199	7467	8763	8218	7269
Units UCL	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069	7845.5069

Figure 9. Total AWPs Requisitions to ALCs

Changes in the Value of One or More SCOR Metrics

As reflected in Figure 10 on the next page, reducing the CWT for bits n' pieces drove reductions in the number of incidents that maintenance personnel had to wait for bits n' pieces to repair major end items. This corollary reduction has several benefits. For example, this lessens the number of times PDM would have to re-sequence job orders or production tasks, thereby reducing management overhead expenses. Lessening the number of instances that a critical repair is "put on hold" increases ALC delivery performance, and also reduces the order fulfillment lead time. With less idle work-in-process, customer levels for items decline as they reduce the amount of production variability they have to guard against—thus reducing inventory days of supply. Furthermore, the ALCs experience greater production flexibility, as the likelihood having a needed bits n' piece to perform a repair increases. Last, maintenance personnel in the field see less need for cannibalizations, as availability rates climb and lead times shrink. In total, the entire supply chain benefits from the reduction of CWT and AWP at the ALCs.

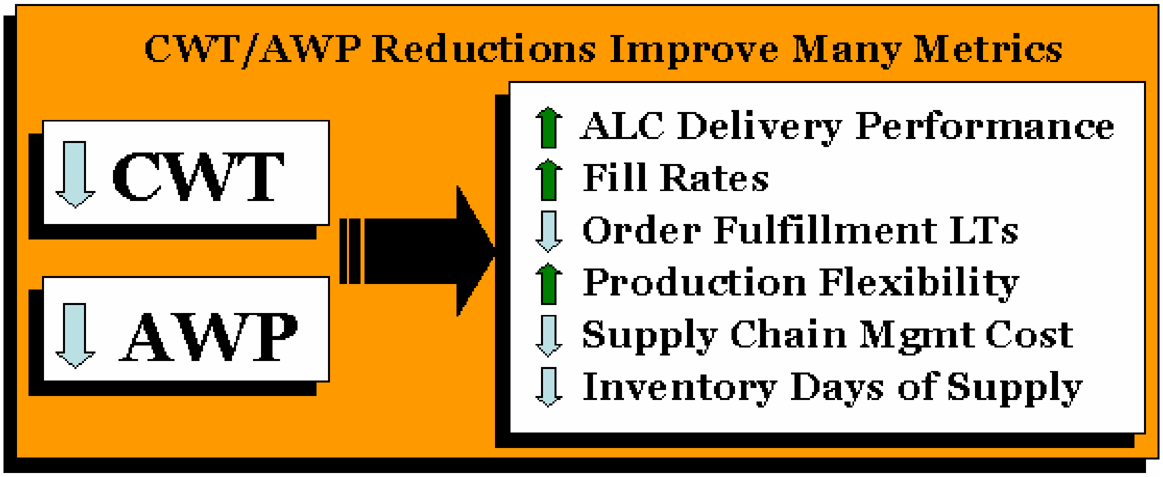


Figure 10. CWT/AWP Reductions Drive Improvements across the Supply Chain

7. Outline how the success of this effort supports the organizational objectives described in Section 1, Item 3 – **15 pts**

COLT Supports Organizational Objectives

Having the right spare parts available when maintenance needs them is integral to the success of any maintenance activity. Lack of these parts causes work stoppages in the repair operation and places increased labor requirements on expediting the procurement of the part. In the final analysis, not having a bit n' piece at the right place, at the right time—has an adverse impact on aircraft availability and impacts the readiness of the major commands. Prior to COLT, the primary influence on the setting of stock levels for the DLA-managed consumable bits and pieces was the historical demand experience for the item. The process of allocating available dollars to stock these items was primarily manual, and very labor intensive. COLT brought several new innovations to this process. In the first analysis, it used an automated state-of-the-art modeling process to allocate dollars to items with the highest potential for return on investment. Secondly, it measured the propensity for DLA to deliver the material by considering their stockage capability. Lastly, it controlled the expenditure of GSD monies to ensure that end of year unit cost ratio would be met and obligation authority would not be exceeded. The end result of the application of COLT can be seen in the dramatic impact it has had on the time our maintenance customers have to wait for their material, and the decrease in instances of repair actions experiencing parts shortages.

In addition, there are several other positive effects.

1. MSD pipeline reduction. Although this effect has not yet been directly measured, because there are many factors which impact it, when repair cycle times are reduced for producing Material Support Division (MSD) components, the overall MSD pipeline requirement will be reduced. Currently, the estimated value, per day, of the MSD pipeline requirement is over $50M.

2. No legacy system modification. Legacy systems, such as D035K, are extremely expensive to modify via Computer System Requirements Documents (CSRDs). Even minor changes, e.g. adding “cause codes” for back orders, cost around $100,000. Major changes, e.g. adding total asset visibility, can cost several million dollars. COLT did not cause any CSRDs to legacy systems.
3. Time savings for ALC supply analysts. Prior to COLT implementation, an estimated 324 man-days or nearly 2,592 man-hours per year were spent across the three ALCs performing stock level setting/validations. That time is now reinvested by those analysts in other analysis activities to further improve supply chain performance.
4. Calculating future funding. The COLT model can run in performance or budget allocation modes. In performance mode, it takes the desired performance level defined in CWT (or IE/SE, if desired) and will compute the required funding, by item, to achieve that performance. That assists budgeting, and recently has proved beneficial in computing “what if” scenarios for the cost of potential future surge operations to support war. In budget allocation mode, it takes the available funding and determines the appropriate allocation to produce the lowest overall average CWT for the command.
5. Source of supply analysis. Because COLT evaluates projected DLA performance, it is a useful tool to target problem items for the source of supply. Basically, COLT tends to set higher stock levels on items that have poorer support. Those items can then be evaluated for improvement, thus providing the framework for continuous supply chain improvement.
6. Customer synchronization. COLT identified typical maintenance order quantities and takes them into consideration when setting levels to assure that “whole” quantities are obtained to support maintenance jobs.

Section 3: Knowledge Transfer

1. Describe the efforts to share lessons learned from this effort with other internal organizations **– 5 pts**

Lessons Learned and Shared

There have been three formal efforts to partner with internal organizations and to share lessons learned.

First, members from the IPT have been called on to share their findings/research with the Air Force Spares Campaign as well as the Depot Maintenance Review Team. Specifically, the discussion focused on how to export the COLT concepts to other than DLA managed spare parts. The concept applied in this initiative, leveraging wholesale support data, is equally applicable to items managed by the Air Force as well as items managed by other services. There are implementation issues to be considered, but the Air Force is currently seeking to apply COLT principles to these other consumable parts.

In addition to working with non-DLA spares, the team has extended the discussion to brainstorm additional ways that DLA and the AF can work together to improve customer support. Since COLT links wholesale and retail levels of support to the expected CWT, it is now possible to identify cases where changes in wholesale support would have the biggest impact on the supply chain as a whole. The goal of this effort is to be able to communicate with DLA the ways that they can best help AF supply help the warfighter. Academic tests are currently underway with DLA to further explore this concept of total supply chain optimization.

Lastly, COLT now provides a way to quantify the cost required to achieve a better level of support. HQ AFMC/LGR plans to use this tool in the future to help forecast budget requirements for consumable items, and the tool as already been used by the Air Force to help develop Cost of War estimates. Now, instead of saying we need $X million to support the effort, COLT allows us to say that we need $X million to support this effort otherwise performance will degrade by X% over the next fiscal year. Quantifying the impact of an under-funded requirement will go a long way in ensuring integrity of the budgeting process.

Last, an aggressive communication plan was developed and executed. COLT has been published in AFMC's *The Leading Edge* magazine and in the AFMC Director of Logistics Newsletter. It was migrated into the AF Spares Campaign. It has also been briefed to students at the Air Force Institute of Technology, to senior leaders and managers at the AFMC Supply Chain Manager's (SCM) Conference, and to the Air Force Material Management Board (AFMMB). As of 1 February 2003, an article has also been forwarded for publication in the Air Force Journal of Logistics.

2. Explain how this initiative can be transferred to other organizations, and specify the likely candidates for transference – 5 pts

How Can This Initiative Be Transferred?

HQ AFMC has advertised the achievements of the COLT initiative, and continues to work closely with DLA, AF bases, and depots in determining where and how COLT can be applied. The concept of setting levels to minimize CWT—based on a view of the suppliers historical delivery profile and current asset position—has many applications. For instance, how might Consumable Readiness Spares Package (CRSP) requirements to support contingency operations change with this type of information? Given COLT is able to determine the level of funding required to meet a stated CWT, could COLT not also compute the GSD requirement needed to support the ALCs total repair requirement? This analysis of this latter question is already underway at HQ AFMC. In short, AFMC has already begun targeting processes to transfer this initiative.

Likely Candidates

The most likely candidates to receive a "transfer" from this supply chain initiative are the Air Force bases. Each base uses a much smaller amount of consumable parts than an ALC, but collectively—AF bases consume approximately $1.2B per year in DLA bits n' pieces (versus $800M for all the ALCs). Fundamentally, the concept to leverage wholesale support information to improve retail parts support is still valid. Two tests are currently underway at two major command bases (Seymour-Johnson AFB, ACC; Laughlin AFB, AETC) to assess the value that COLT can bring to their environments. Preliminary results from these tests are expected by the end of September 2003. If improvements are found, then an AF-wide implementation of COLT would be the next step.

HQ DLA has also expressed interest in the COLT model. Since DLA currently uses “supply availability” as their bottom line metric, COLT could prove to be an important addition to their analytic tools.

Last, the AFMMB is interested in applying COLT-like logic to AF-managed consumables. In short, there are plenty of candidates on the near-term horizon that stand to reap the benefits of the knowledge gained by the development and implementation of this project.

Summary

COLT has revolutionized our concept of level setting, the potential for leveraging information technology, and our paradigm of increased funding is needed to increase support. As with any true initiative to improve performance, there are still gains to be made in the application of COLT level setting. For example, COLT could:

1) Factor item “criticality” into leveling
2) Link consumable items to weapon system readiness drivers

But what is the bottom line? AFMC will continue to seek to improve supply chain performance from supplier to the weapon system customer. COLT has already significantly reduced CWT and improved support to depot maintenance—within the budgeted UCR. Through COLT, AFMC has established a standardized level-setting process by replacing 3 independent processes with COLT. Day to day, there are many uses (budgeting/distribution/level setting/analysis) of the information that COLT can give us—thus reducing the time/workload to analyze and set levels. By leveraging this information—and in particular, the automated collaboration process between DLA and the AF--AFMC is confident that it will continue to improve its performance in supplying the warfighter world class systems to meet existing and emerging threats.

Acronyms

ACC	Air Combat Command
AETC	Air Education Training Command
AF	Air Force
ALC	Air Logistics Center
AFMC	Air Force Materiel Command
AFMMB	AF Material Management Board
AWP	Awaiting Parts
BO	Backorder
CAP	Constraints Analysis Program
COLT	Customer Oriented Leveling Technique
CRSP	Consumable Readiness Spares Package
CSRD	Computer System Requirement Document
CWT	Customer Wait Time
DoD	Department of Defense
DLA	Defense Logistics Agency
DMAG	Depot Maintenance Activity Group
EOQ	Economic Order Quantity
GSD	General Support Division
HQ	Headquarters
IE	Issue Effectiveness
IPT	Integrated Product Team
MSD	Materiel Support Division
MS	Microsoft
NMCS	Not Mission Capable Supply
OA	Obligation Authority
OC	Oklahoma City
OC-ALC	Oklahoma City Air Logistics Center
OO	Ogden
OO-ALC	Ogden Air Logistics Center
PC	Personal computer
PDM	Programmed Depot Maintenance
SCOR	Supply Chain Operations Reference (model)

SE	Stockage Effectiveness
TNMCS	Total Not Mission Capable Supply
UCR	Unit Cost Ratio
UCT	Unit Cost Target
WARRS	Wholesale & Retail Receiving/Shipping
WR	Warner Robins
WR-ALC	Warner Robins Air Logistics Center

Glossary

Customer Wait Time (CWT): CWT accounts for same percentage and how long requesters wait for backordered parts. CWT provides an accurate representation for how well the customer is being supported and is an important link to weapon system support

Issue Effectiveness (IE): percentage of time supply has any part requested

Stockage effectiveness (SE): percentage of time supply has stocked part when requested

Unit Cost Ratio (UCR): equals total obligations divided by total sales

Appendix 1. COLT Math Model

There are two key metrics that we focus on for each scenario: customer wait time and cost of inventory. A decrease in the average CWT indicates that depot maintenance is getting parts more quickly from depot supply and the cost of inventory quantifies the dollar value of the average on-hand inventory. We realize that issue and stockage effectiveness are commonly used supply metrics and the following paragraph explains why we have opted for CWT.

There are three primary reasons why we use CWT throughout this study. First, CWT was recently accepted as the DoD's primary supply performance metric. Second, IE/SE alone do not indicate how well depot maintenance is being supported, in that they don't account for how long the customer waits once an item is backordered. For example, two each had 10 requisitions for 1 each during a 12-month period and both had 9 of those 10 requisitions filled immediately. The SE for both parts is then 90% over this 12-month period. Now, suppose that the backordered requisition on part 1 was filled in 2 days and the backordered requisition on part 2 was filled in 200 days. Clearly, the customer waiting for part 2 was "hurting" longer, but looking at IE or SE would not tell you this fact. Focusing on CWT accounts for how long each of the customers requisitions are placed on backorder. Finally, CWT incorporates issue effectiveness. Why would you want to use IE when CWT includes all of the IE information, plus the delay factor? To prove this point, let's look at the equation for CWT.

$$CWT = IE*(0) + (1-IE)*(\text{Time on Backorder})$$

CWT accounts for the percentage of the time that depot supply has the part on the shelf (IE) and the fact that there is essentially "zero" delay in these cases and then the percentage of the time that depot supply has to backorder the part times how long, on average, it takes to satisfy the requisition. While IE is a partial metric, CWT tells the complete story.

Now that we explained why we opted for CWT as the primary performance metric, we will step through exactly how this metric is calculated. Specifically, the CWT for any given item can be defined as the expected maintenance backorders divided by the DDR.

$$CWT = EBO/DDR$$

Expected backorders are defined as the average number of units on a backorder status at a point in time. Dividing by the daily demand rate tells indicates how long, on average, the customer will wait for their requisition to be filled. For example, if a given item, on average, has two backorders, and the daily demand rate is 1, we know that we are waiting 2 days for our requisitions to get filled. Likewise, if our DDR dropped to 0.5 and the backorders stayed at 2, we would expect an average customer wit time of 4 days.
We have just shown how to calculate the CWT for a single item, but our model looks at the demand-weighted average CWT across all items at an ALC. The aggregate CWT is computed by taking the sum of the individual expected backorders and dividing by the sum of the DDRs.

$$CWT = \frac{\sum_i EBO_i}{\sum_i DDR_i}$$

Adding up the daily demand rates is very simple; the only issue that remains is how to calculate the expected backorders. We have already hit on the fact that expected backorders indicates the number of parts, on average, that depot supply will "owe" to depot maintenance. The equation that computes this value resides in the technical report entitled <u>Application of Negative Binomial Probability to Inventory Control</u>, written in 1974 by Deemer, Kaplan, and Kruse from the Institute of Logistics Research, US Army, Logistics Management Center. This is a well-established and accepted technique for projecting the number of stock-outs for an inventory system. I hesitate to include the formula in this document, but it basically calculates the expected number of parts due to maintenance from base supply based on depot supply's ROP, EOQ, safety level, the item's demand rate, variability of that demand, and the expected delay time from the wholesale organization. It assumes that demands occur according to a Poisson probability distribution (a well-accepted inventory modeling practice), and that the average demand rates are not constant over time, which we suspect they are not, but rather follow a Gamma probability distribution. It can be statistically proven that this results in demands over time following a Negative Binomial distribution., Again, this is a well-established technique for modeling demand patterns in an inventory system, so we used this assumption to evaluate the expected backorders. At any rate, for documentation purposes, here is the probabilistic equation we used for calculating expected backorders:

Definitions:

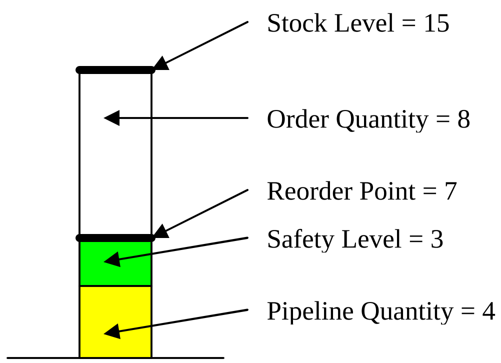
VTMR = variance of pipeline quantity (σ^2)/mean of pipeline quantity (μ)
ROP = reorder point
EOQ = economic order quantity
r = μ/σ^2
p = 1/VTMR
q = 1 – p
NB(a;b) = evaluation of the negative binomial distribution evaluated at parameters "a" and "b"

$$EBO = \frac{1}{2*EOQ}\left\{\begin{array}{l} \left[(ROP+EOQ)^2 + ROP + EOQ\right]*NB(ROP+EOQ;r) - ROP(ROP+1)*NB(ROP;r) + \\ \frac{rq}{p}*\frac{(r+1)q}{p}*\left[NB(ROP+EOQ-2;r+2) - NB(ROP-2;r+2)\right] + \\ 2*\frac{rq}{p}*\left[ROP*NB(ROP-1;r+1) - (ROP+EOQ)*NB(ROP+EOQ-1;r+1)\right] + \\ EOQ*\left[2*\frac{rq}{p} - (2*ROP+EOQ+1)\right] \end{array}\right\}$$

The important thing to grasp from this equation is that we are calculating the expected number of parts due to depot maintenance, at any given point in time, as a function of the reorder point, order quantity, true pipeline time, demand rate, and the variance of the pipeline quantity. Note: In the evaluation of a "1-for-1" order policy, the EOQ in this equation is simply set to the lotsize. This is how all of the fixed level parts are being run through the evaluation tool. This equation allows us to compute our first metric, CWT, as expected backorders divided by the daily demand rate. Now we need to show how the cost of the average on-hand inventory was calculated. The accepted equation for calculating the average on hand inventory is:

$$\text{Avg On-Hand} = \tfrac{1}{2}\,\text{EOQ} + \text{Safety Level}$$

We computed this average on-hand value for each of the NSNs in the study and then found the average cost of the inventory by multiplying the unit price and the average inventory of the item. Summing across all NSNs yields the total average cost of inventory for a stockage policy. It is useful here to step through exactly what we mean by safety level, and other inventory terminology. These definitions are best shown using a picture. Actual numbers have been attached and will be used in an example later in this section

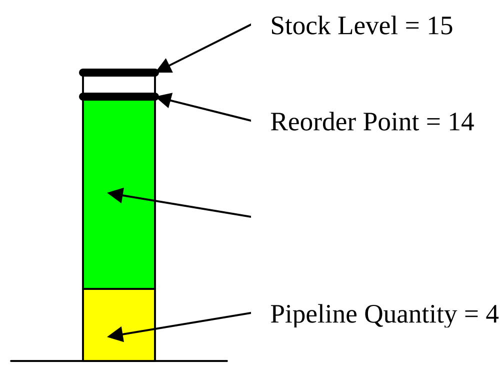


Order Quantity = Stock Level – Reorder Point

Safety Level = Reorder Point – Pipeline Quantity

** The Pipeline quantity is number of expected "demands" during the pipeline and therefore the minimum possible reorder point (when safety = 0)

The most commonly used ordering policy in the set of data that we used for this study was the fixed special level. The items with these fixed levels tend to have relatively small order quantities (lotsize) and large safety levels. As you might expect, large safety levels tend to drive high costs of average on hand inventories. The illustration to the right shows what happens to the safety level when we keep the same stock level and use a fixed special level on an item with a lotsize of 1.



In the first case, where the order quantity was 8, the average on-hand inventory was ½(8) + 3, or 7. In the second case, where we revert to the fixed special level, the average on-hand inventory was ½(1) + 10, or 10.5. This explanation has hopefully illustrated the fact that even when we keep a given stock level, the ordering policy has a significant impact on how much inventory we have sitting on the shelves at any point in time.

The previous three pages have explained the measures that we will use to evaluate proposed stockage policies, CWT and average cost of inventory. Specifically, we will be looking at the trade-offs between CWT and cost to determine which policies are more “efficient.” It is important to look at both measures simultaneously. It would be very easy to establish a policy that results in a very low expected CWT. By setting the stock levels on all parts to 100,000 and ordering on a “1-for-1” basis we would expect a very small CWT, but our cost would likely be enormous. At the same time, we could achieve a very small cost of inventory by zeroing out the safety levels on all of our items, but a poor CWT would result. In order to get the most out of this tool, it is necessary to balance the changes in performance (CWT) with the changes in cost.

A third measure, the Unit-Cost Ratio, was added to COLT following the April 2001 IPT meeting and has become the **primary model constraint**, replacing the average cost of inventory. The UCR is computed as the total obligations for an ALC during the year divided by the total amount of sales during that same year. Each of the ALCs must achieve a set target by the end of each fiscal year. Sales are basically fixed, in that you sell what your customer buys, and so obligations are used to control the UCT.